A Reference Model for Representing Real Characters into the 3D Virtual Space

Ji-Seong Jeong¹, Sin Ae Kwon¹, Jin A Park¹, Chan Park¹, Nakhoon Baek², Kwan-Hee Yoo¹,*

¹Dept. of Digital Informatics and Convergence, Chungbuk National University, 52 Naesoodong, Heoungduk, Cheongju, Chungbuk, 361-763, South Korea 
{farland83,*khyoo}@cbnu.ac.kr
²Dept. of Computer Science and Engineering, Kyungpook National University, 1370 Sankyeok-dong, Buk-ku, Daegu, South Korea, oceanrul@gmail.com

Abstract. In this paper, we propose a reference model for representing real characters in the 3D virtual space. Most systems have adopted virtual characters into the 3D virtual space to give more realistic situation, where the virtual characters have been controlled by user-steered interfaces. In order to take user immersion, we need to represent real characters into the 3D virtual space. This paper describes how to represent the real characters in the 3D virtual space, and how to transform them according to the user control. The experimental results of our proposed method show that immersion and participation of learners are continuously increased.

Keywords: 3D virtual space, virtual character, real character

1 Introduction

In order to enhance communication with each other among three partners for educational services: learners, teachers and learning systems, 2D educational systems start to be migrated to 3D based learning systems, where 3D virtual space represents the real learning world[1,2]. Many researchers have studied to find out technical factors, which will be operated in the 3D virtual space to provide the three issues: immersion, interaction, and virtual experience for the educational application services [3-5]. One of them is to deal with how do learners as well as teachers participate in the 3D virtual educational space and how is their participation represented in the space. However, there are no results on the representation of real characters into the 3D virtual space and then animating them. The issues are discussed in this paper.

This paper is organized as follows: Section 2 illustrates the proposed method for mapping the real characters into the 3D virtual space and for moving them naturally in the space. Section 3 describes its implementation results, and Section 4 points out further research directions.

* A correspond author
2 Representing Real Characters into the 3D Virtual Space

Fig. 1 describes globally a method for embedding real characters into the 3D virtual space. First of all, images containing the real characters should be captured from an input camera. The captured images will be processed with the computer vision tools such as background removal and computation of feature regions [6]. Letting the real character space be the real world space where real characters can move, the real character space can be constructed as a bounding box. The obtained bounding box will be mapped into a box in the 3D virtual space.

Fig. 1. System configuration for embedding real characters into the 3D virtual space.

Now, we compute the bounding box in the real space. Before discussing the processing, some notations are introduced. Let $MRB$ and $MVB$ be the movable bounding box in real space and another in 3D virtual space, respectively. Clearly, $MRB$ can be defined with two corner points $RB_{min}(RX_{min}, RY_{min}, RZ_{min})$ and $RB_{max}(RX_{max}, RY_{max}, RZ_{max})$, while $MVB$, which is given by a user, can be also defined with two corner points $VB_{min}(VX_{min}, VY_{min}, VZ_{min})$ and $VB_{max}(VX_{max}, VY_{max}, VZ_{max})$. From now on, we are discussing again a method to calculate the real character space $MRB$. Since the captured image represents the whole of real space in two dimensions, let $(Ix, Iy)$ be the size of the captured image, we can give that $RX_{min}=0$, $RY_{min}=0$, $RX_{max}=Ix$, and $RY_{max}=Iy$. The remaining two values, $RZ_{min}$ and $RZ_{max}$, of $MRB$, should be taken from the captured image to naturally simulate the movement of the real characters in 3D virtual space. To do it, we are able to use the area of the region including user’s face, which can be obtained by applying the method proposed by Hsu, et.al [9]. Let $SRR$ ($LRR$) is defined as the area of the face region when a user becomes far from the camera (respectively, when a user gets close enough to the camera). Then we assign $RZ_{min} = SRR$, and $RZ_{max} = LRR$. The depth of the real character at a specific time can be calculated through normalizing the area of smallest rectangular regions containing a real character’s face at the time with $SRR$ and $LRR$. The mapping between the two bounding boxes is executed through texture mapping of an image containing real characters into an object with the mapped z-value in the 3D virtual space.

3 Experimental Results

Our experimental system is configured with an input device and a PC with 2.66GHz Quad-core CPU and 4GB RAM, OpenCV, OpenGL, and Microsoft Visual Studio.
2010. The experimental results show that the proposed method achieves 13~18 frames per second (fps) for embedding real characters extracted from the captured images into the 3D virtual space. Two figures in Fig. 2 show movement results of the real character obtained by applying the mapping function after computing the real bounding box.

![Fig. 2. The movement results obtained by applying our proposed method.](image)

### 4 Conclusion

Our experimental results show that real characters obtained from a general camera can be embedded into the 3D virtual space. However, at this time, this method is hard to directly achieve natural animations of real characters as well as their visualization in the 3D virtual space.

**Acknowledgments.** This research was financially supported by the Ministry of Education, Science Technology (MEST) and National Research Foundation of Korea (NRF) through the Human Resource Training Project for Regional Innovation, and by the ICT standardization program of MKE (The Ministry of Knowledge Economy)

### References

4. J. S. Jeong, C. Park, J. J. Han, M. S. Im, R. H. Jang, M. Kim and K. H. Yoo, Development of a 3D Virtual Studio System for Experiential Learning. CCIS (Communications in Computer and Information Science). 150 (2011)